# Assessment history

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# Part 1: Bering Sea

# (See Appendix 2.3 in SAFE chapter)

# Some “pinch points” in history (1 of 2)

- 1992: The 1989 year class, which had previously appeared strong, “disappeared” from the 1992 agecomp data
  - Result 1: assessment “addendum” produced
  - Result 2: production ageing ceased for several years
- 2006: Very late in the assessment cycle, model was discovered to have converged at a local minimum
  - Result 1: assessment “addendum” produced
  - Result 2: extensive convergence testing in future assessments
  - Result 3: ban on informative priors for double-normal selectivity
  - Result 4: public interest in proposing alternative models

# Some “pinch points” in history (2 of 2)

- 2007: Mismatch noted between mean lengths at age and survey sizecomp modes
  - Result 1: use of age data called into question again
  - Result 2: survey selectivity basis switched from length to age
  - Result 3: survey index units switched from biomass to numbers
  - Result 4: Ageing bias incorporated into models (eventually)
- 2011: Teams disliked method used to determine the amount of time variability in certain model parameters
  - Result 1: author’s preferred model excluded from assessment
  - Result 2: quantities frozen at 2009 levels for years to come
- And, the big question for the last 25 years or so: Why do the models always say that the trawl survey is missing large fish?

# Pre-2005: timeline

- Pre-1985: Simple projections of current survey numbers at age
- 1985: Projections based on 1979-1985 survey numbers at age
- 1986-1991: *ad hoc* separable age-structured FORTRAN model
- 1992: FORTRAN-based Stock Synthesis (age-based data)
- 1993: Models continued using SS (length-based data only)
- 2004: Models continued using SS (length- *and* age-based data)
  - New age data, based on revised ageing protocol

# Pre-2005: main features of the early SS models

- Start year = 1977
- Three seasons (Jan-May, Jun-Aug, Sep-Dec)
- Four fisheries (Jan-May trawl, Jun-Dec trawl, longline, pot)
- $M$, $Q$ set at fixed values
  - Efforts at internal estimation of $M$, $Q$ unsuccessful
- Double-logistic selectivity for all fleets (fisheries and survey)
- No fleets constrained to exhibit asymptotic selectivity
- Sizecomp input sample size = square root of true sample size
- Survey index standard deviations set to RACE-reported values
- Agecomp data used in “marginal” form

# Counts of vetted models under ADMB-based SS

| Year | Preliminary | Final | Other | Comments |
|---|---|---|---|---|
| 2005 | | 3 | | |
| 2006 | | 9 | | |
| 2007 | 4 | 4 | 30 | Other = spring workshop |
| 2008 | 5 | 8 | | |
| 2009 | 8 | 14 | | |
| 2010 | 6 | 3 | | |
| 2011 | 7 | 5 | 13 | Other = CIE review |
| 2012 | 14 | 4 | | |
| 2013 | 4 | 1 | | |
| 2014 | 6 | 2 | | |
| 2015 | 8 | 2 | | |
| Subtotal: | 62 | 55 | 43 | |
| Total: | | | 160 | |

- Counts do not include a very large number of models that were explored, but not vetted
- Accepted model has been constant since 2011

# Current review cycle, instituted in 2010

- February or April: Author compiles list of possible candidate models based on Team/SSC minutes from last year and public comments
- March or May: Teams (or subcommittee) meet via teleconference, recommend up to 6 models for inclusion in preliminary assessment
- April or June: SSC adopts or modifies the Teams' list of recommended models
  - Author can add models at his discretion
- September/October: Team/SSC review preliminary assessment, recommends models for inclusion in final assessment
  - Author can add models at his discretion
- November/December: Team/SSC review final assessment, choose final model, suggestion possible candidate models for next year

# History of seasonal structures

- 1986: Monthly seasonal structure (12 months)
  - Motivation: avoid assumption of constant intra-annual effort
- 1992: Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec (4 seasons)
  - Motivation: switch to SS required simplifying structure
- 1993: Jan-May, Jun-Aug, Sep-Dec (3 seasons)
  - But, seasonal *selectivity* for Jan-May and Jun-Dec trawl only
  - Motivation: industry request
- 2007: Seasonal selectivity for all three gears, all three seasons
  - Motivation: divergent trends between survey and longline fishery
- 2010: Jan-Feb, Mar-Apr, May-Jul, Aug-Oct, Nov-Dec (5 seasons)
  - Motivation: find periods of reasonably constant effort (AIC)

# History of final catchability ($Q$) values

- 1986-2005: $Q$ fixed at 1.00
- 2006: $Q$ estimated at 0.57, with LN(0,0.3) prior distribution
- 2007: $Q$ estimated at 0.72, with uniform prior distribution
- 2008: $Q$ estimated at 0.71, with uniform prior distribution
- 2009-2015: $Q$ fixed at 0.77
  - Estimated in the 2009 assessment by setting average $Q \times$selectivity across the 60-81 cm range equal to 0.47 (point estimate from Nichol et al. 2007)

# Some things we tried: data (1 of 2)

- Use of data sets not included in current model
  - NMFS longline survey data
  - IPHC longline survey data
  - Bering Sea slope trawl survey data
  - Pre-1982 Bering Sea shelf trawl survey data
  - Jan-May longline fishery agecomp data (1 year)
- Use of data sets included, but not used for fitting, in current model
  - Longline fishery CPUE data
  - Mean-length-at-age data

# Some things we tried: data (2 of 2)

- Disuse of data sets included in current model
  - All agecomp data
  - Sizecomp data for which corresponding agecomp data exist
  - All fishery sizecomp data
- Data weighting
  - Input sample size ($N$) set equal to square root of true $N$
  - Input $N$ based on rescaled bootstrap
  - Iterative re-weighting of input sample sizes
  - Agecomp input $N$ tuned to set mean input $N$ = mean effective $N$
  - Doubling the standard error of the survey index
  - Internal estimation of survey index standard errors

# Some things we tried: $M$ and $Q$ (1 of 2)

- Specification/estimation of $M$ and $Q$
  - Both $M$ and $Q$ fixed
  - Fixed $M$, $Q$ estimated
  - Fixed $Q$, $M$ estimated
  - Both $M$ and $Q$ estimated
- Age-dependent $M$
  - Separate $M$ estimated for ages 1 and 2
  - Separate $M$ estimated for ages 9+
  - Separate $M$ estimated for ages 8, 9, …

# Some things we tried: $M$ and $Q$ (2 of 2)

- Estimation of $Q$
  - Non-constraining uniform prior
  - Informative prior based on subjective judgment
  - Prior based on archival tags (random effects)
  - Prior based on archival tags (fixed effects)
- Time-variability in $Q$
  - None
  - Function of temperature
  - Random walk **dev** vector
  - Ordinary **dev** vector

# Some things we tried: growth (1 of 2)

- Length at age parameters
  - All parameters constant
  - von Bertalanffy $K$ varies by *cohort*
  - Length at age 1.5 varies by year
  - All von Bertalanffy growth parameters vary by year
  - Length at age 0 constrained to be positive
  - Richards growth function
- Weight-length parameters (estimated externally in all cases)
  - Constant across years and seasons
  - Constant across years, with seasonal values set at data means
  - Constant across years, with phenological model for seasons
  - Variable across years, with phenological model for seasons

# Some things we tried: growth (2 of 2)

- Estimation of ageing bias parameters
  - "Trial and error" estimation of mean ageing bias parameters
  - Internal estimation of mean ageing bias parameters
  - Internal estimation of ageing bias variance parameters
- Estimation of length-at-age parameters
  - All length-at-age parameters estimated outside the model
  - All length-at-age parameters estimated inside the model
  - Some parameters estimated inside, others outside
  - Standard deviation of length-at-age estimated internally
  - Standard deviation of length-at-age estimated externally

# Some things we tried: selectivity (1 of 2)

- Selectivity functions
  - Double logistic
  - Double normal
  - Exponential-logistic
  - Spline
  - Random walk with respect to age
- Asymptotic selectivity
  - Jan-May trawl fishery selectivity forced to be asymptotic
  - Longline fishery selectivity forced to be asymptotic
  - Trawl survey selectivity forced to be asymptotic
  - “Least dome-shaped” fleet forced to be asymptotic
  - Set of fisheries with asymptotic selectivity chosen by algorithm

# Some things we tried: selectivity (2 of 2)

- Selectivity basis
  - Function of length
  - Function of age
- Time-varying survey selectivity
  - Annually varying: ascending limb only
  - Annually varying: all parameters, potentially
- Time-varying fishery selectivity
  - Constant within ~10-year blocks
  - Constant within blocks of variable length chosen by AIC
  - Constant within blocks chosen by **dev** vectors
  - Annually varying (all parameters, potentially)

# Some things we tried: constraining *devs*

- Specification/tuning/estimation of $\sigma$ for **dev** vectors
  - Subjective specification
  - Tuning each $\sigma$ to stdev(**dev**)
  - Tuning each $\sigma$ by the method of Thompson and Lauth (2012)
  - Tuning each $\sigma$ by the method of Thompson (2015)
  - Tuning each $\sigma_Q$ by setting survey index RMSSR=1
  - Internal estimation of $\sigma_R$

# Some things we tried: prior distributions

- Parameters estimated using informative prior distributions
  - None
  - Some
  - All
- Types of prior distributions
  - Lognormal
  - Normal
  - Symmetric beta
  - Informative (i.e., constraining) uniform
  - Non-informative (i.e, non-constraining) uniform

# Some things we tried: miscellaneous (1 of 2)

- Agecomp format
  - Agecomp data used in “marginal” form
  - Agecomp data used in “age conditioned on length” form
- Regime shift
  - 1976-1977 regime shift “recruitment offset” fixed at zero
  - 1976-1977 regime shift “recruitment offset” estimated
- Start year
  - Start year = 1964
  - Start year = 1977
  - Start year = 1982

# Some things we tried: miscellaneous (2 of 2)

- Number of disequilibrium age groups in the initial vector
  - 3 age groups
  - 10 age groups
  - Number chosen by AIC
- Maturity basis
  - Function of length
  - Function of age
- Trawl survey index units
  - Expressed as biomass
  - Expressed as number of fish
- Stock-recruitment relationship
  - None
  - Ricker (parameters estimated)

# Part 2: Aleutian Islands

# (See Appendix 2A.3 in SAFE chapter)

# Pre-2011

- The AI Pacific cod stock was managed jointly with the EBS stock, with a single OFL and ABC
- Prior to the 2004 assessment, results from the EBS model were inflated into BSAI-wide equivalents using ratios based on survey biomass point estimates from the two regions
- Beginning with the 2004 assessment, the ratios were based on smoothed survey biomass estimates generated by a random-walk Kalman filter

# Counts of vetted models for separate AI stock

| Year | Tier 3 | | Tier 5 | |
|---|---|---|---|---|
| | Preliminary | Final | Preliminary | Final |
| 2011 | 0 | 0 | 1 | 1 |
| 2012 | 2 | 4 | 0 | 0 |
| 2013 | 3 | 2 | 0 | 2 |
| 2014 | 3 | 2 | 0 | 1 |
| 2015 | 4 | 1 | 1 | 2 |
| Subtotal: | 12 | 9 | 2 | 6 |
| Total: | 21 | | 8 (only 3 of which are unique) | |

- Although models for separate management of the AI stock were first proposed in 2011, none were adopted until 2013
- Accepted model has been constant since 2013

# 2011

- Preliminary assessment:
  - A Tier 5 model based on the same Kalman filter approach that had been used to inflate EBS model results into BSAI-wide equivalents since 2004 was applied to the AI stock as a stand-alone model
- Final assessment:
  - Because no new survey data had become available since the preliminary assessment, the Tier 5 Kalman filter model was not updated
  - Anticipating that an age-structured model would soon be accepted for this stock, the SSC did not accept the Tier 5 Kalman filter model, so the AI stock continued to be managed jointly with the EBS stock

# 2012 (1 of 2)

- Preliminary assessment:
  - Two age-structured SS models were presented
  - Both were simplified versions of the 2011 EBS model:
    - Only one season
    - Only one fishery
    - Fishery selectivity forced asymptotic
    - Fishery selectivity constant over time
    - Ageing bias not estimated (no age data yet available)
    - $Q$ tuned to match the Nichol et al. value for the GOA/AI net
  - SSC gave notice that it would not accept any model for this stock prior to the 2013 assessment

# 2012 (2 of 2)

- Final assessment:
  - Four age-structured SS models were presented
  - One of these omitted pre-1991 survey data
    - Some assessments of other AI species used the entire survey time series; others omitted the pre-1991 data
    - SSC requested that all assessment authors of AI species evaluate AI survey information to ensure that the same standardized survey time series is used
  - None of the age-structured models were accepted

# 2013 (1 of 2)

- The AI assessment authors recommended that, as a default, pre-1991 survey data be excluded from all AI models, because the dimensions and configurations of the nets used in the pre-1991 surveys varied among nations and years, for example:
  - Data from the Japanese vessels were excluded from the 1980 biomass estimate, and the two U.S. vessels in that year used two different nets
  - In 1983 and 1986, data from both Japanese and U.S. vessels were used in the estimates, but the Japanese used different gears in those two years
- SSC accepted the authors' recommendation

# 2013 (2 of 2)

- Preliminary assessment:
  - Three age-structured SS models were presented
- Final assessment:
  - One year of survey agecomp data now available (2012)
  - Two age-structured SS models were presented
    - Resulting estimates from early portion of time series were difficult to believe, for example enormous $F$ and tiny $B$
    - Reliability of pre-1991 *fishery* data now called into question
  - Two Tier 5 models were presented:
    - Random-walk Kalman filter
    - Simple random effects model, similar to Kalman filter
  - SSC accepted the simple random effects model

# 2014

- Preliminary assessment:
  - Three age-structured SS models were presented
  - Pre-1991 fishery data were excluded from all models
    - In addition to pre-1991 *survey* data, as in 2013 assessment
- Final assessment:
  - Second year of survey agecomp data now available (2010)
  - Two age-structured SS models were presented
    - Pre-1991 fishery data still excluded
    - However, author was having “second thoughts” about this
  - Simple random effects model also presented
  - SSC accepted simple random effects model (again)

# Some things we tried (1 of 2)

- Time-varying $L_1$ and $L_\infty$
- Multiplying input sample sizes ($N$) by 1/3
- Time-varying $Q$
- Forcing double-normal survey selectivity to be asymptotic
- Allowing fishery double-normal selectivity to be domed
- Setting sizecomp input $N$ so that survey index RMSSR=1
- Time-varying fishery selectivity parameters
- Internal estimation of $\sigma_R$
- Selectivity modeled as random walk with respect to age
- Random walk survey selectivity forced to be monotone increasing

# Some things we tried (2 of 2)

- Estimate $Q$ with prior based on assessments of other AI species
- Estimate $Q$ and $M$ with nonconstraining uniform priors
- Fix $Q$ at 1.00
- Fix the "recruitment offset" for initial agecomp at zero
- Tighten priors to make RW survey selectivity less dome-shaped
- Sizecomp and agecomp input $N$ tuned so that harmonic mean effective $N$ is at least as large as arithmetic mean input $N$

# Some persistent issues through 2014

- The age-structured SS models of the AI stock consistently tended to estimate strongly "pointed" survey selectivity, unless forced to do otherwise
- At the same time, they tended to estimate $Q$ at values less than 1, unless forced to do otherwise
- Together, the above results meant that the models tended to estimate total biomass levels that were 2-4 times higher than the survey biomass
- Authors, Team, and SSC were reluctant to accept this result without a high level of confidence that it was correct